

The performance of automotive systems in conditions other than those tested in the framework of type-approval or self-certification, with TPMS as a case study.

1. General context

1. The "emission case" (revealed in September 2015) related to the use of defeat devices through a software manipulation, highlighted the fact that automotive systems might not perform as expected (i) by the general public and those dealing with environmental issues, and/or (ii) in other conditions than those described in testing procedures. The use of defeat device is prohibited by UN Regulation No. 83, but no procedures are defined to demonstrate compliance during type-approval.
2. This case can be instructive for developing procedures for use in type approval or compliance tests given an increasing use of software in vehicles.
3. WP.29 received information about the discussion that took place at GRRF in the context of IWVTA (WP.29-168-15) and, separately, on the issue of the performance of automotive systems in conditions other than those tested according to the regulated test procedures. WP.29 noted that there are inherent risks that some systems, especially those relying on software (e.g. TPMS and AEBS) could be designed to work only in the limited conditions corresponding to those tested rather than in all the relevant driving conditions. WP.29 agreed that the new regulation on TPMS systems could serve as a case study to inform future consideration by the working party.

2. Possible interpretations of technical provisions

4. Systems controlled by software, which are subject to technical provisions in UN Regulations and UN GTRs, may lawfully be programmed on the basis of these provisions: from the engineering perspective, the provisions set in the applicable regulation(s) may represent the unique (or main) engineering specification, especially if there is no additional functional or customer need to be addressed. This simple fact may explain why the performance of systems relying on software do not always fully meet the expectations of the general public.
5. In some cases, functionality may be required of a system beyond that identified by the regulatory objective, e.g. for airbags, that don't deploy when the driver e.g. drives on kerbstones. Without the programmed "filters", the vehicle sensors would recognize a strong deceleration, interpret it as a crash and deploy airbags. Nevertheless, this functionality should not be contrary to the purpose of the Regulation.
6. In other cases in the past, it was demonstrated that software could be used that circumvent requirements contained in emissions Regulations.
7. In order to avoid unnecessarily restrictive provisions in Regulations, the Regulator tends to introduce *general provisions* in regulations stating that the systems shall also perform in conditions other than those specified in testing procedure (containing precise performance requirements providing robust and reproducible test results).
8. These *general provisions* are initiating practical questions raised by the manufacturers and the authorities about the correct way to verify the compliance of a product with these general provisions. To overcome this type of difficulty, the Working

Party on Noise (GRB) developed Additional Sound Emission Provisions (ASEP) in Regulation No. 51, which correspond to an off-cycle noise test.

9. UN Regulation No. 64 sets performance requirements applied to the evaluation of TPMS responsiveness to puncture, diffusion and malfunction. The text of the regulation contains very specific testing provisions resulting from a long technical discussion, influenced, among others, by the competition between system manufacturers delivering direct pressure measuring systems and others delivering indirect one. The requirements for TPMS were exclusively defined by performance requirements within precise testing protocols. The system shall warn within a given timeframe, when tested under certain conditions.

10. If a test is performed in slightly different conditions (from those defined in the test procedure) and the performance criterion is not achieved, even though it could be expected that the system provide a similar response, no hint is given in the regulation, whether the system performs legitimately i.e. as expected or not.

3. New draft Regulation on TPMS

11. In the framework of the work done on International Whole Vehicle Type Approval, it was decided to separate the provisions related to TPMS from Regulation No. 64 and to create a new regulation specifically on TPMS. In this context, the Working Party on Brakes and Running Gear agreed to remove the reference (initially present in Regulation No. 64) to the testing procedure, whenever possible. A paragraph was also clarified in order to explicitly specify that TPMS shall meet the performance requirements of the Regulation over a wide range of road and environmental conditions encountered within the territory of the Contacting Parties (*general provision*).

12. Such *general provisions*, with the requirements related to overall vehicle performance, have existed for quite a long time often with durability and reliability objectives. Reference can be made, for example, to para. 5.1.4. of UN Regulation No. 79 stating: "The steering equipment shall be designed, constructed and fitted in such a way that it is capable of withstanding the stresses arising during normal operation of the vehicle, or combination of vehicles...". This provision obliges vehicle manufacturers to ensure reliability of steering systems for the entire lifecycle but doesn't specify the enforcement method to verify the compliance with this provision nor the purpose of such provision (product liability, warranty, penalty in case of non-compliance?).

4. Possible ways forward

13. There might be an uncertainty for the authorities on the way to check the compliance with such *general provisions*. This uncertainty could certainly lead to divergences in the way to verify the compliance with the provisions of the given regulation. It might impact a harmonious mutual recognition of approvals. It could create confusion in the case of self-certification regimes.

14. Trying to check the compliance with these provisions on an ad-hoc basis might be very time consuming. Long and extensive tests during the type approval process, aimed at identifying non-legitimate strategies, may not be efficient especially because Type Approval tests may be performed with prototypes; is there certainty that the software presented at type approval would be the same as that employed in production if a manufacture was intent on defeating the requirement? Imposing extensive tests to new vehicles in the framework of Conformity of Production may not be practical for manufacturers and not acceptable for consumers.

15. Inserting the said *general provisions* in a regulation could even lead to difficulties when a non-compliant case is revealed. The general public might reproach the authorities

and regulator as being ineffective as they didn't manage, on the basis of these provisions, to prevent the approval of a non-compliant product.

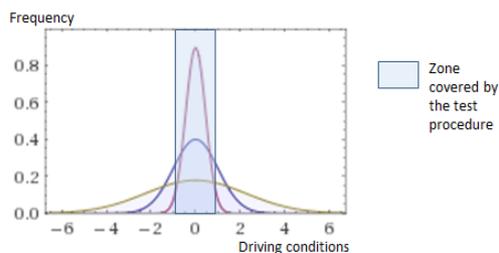
16. Based on these observations, it is proposed to explore possible ways to best address this uncertainty.

A. Additional tests, extending the range of the boundary conditions of the specific type approval tests

17. In the case where a conformity test would be performed for a TPMS system in conditions outside of the boundaries defined by the testing procedure, but in similar conditions to those defined in the testing procedure, can we expect that the system still meet the performance requirements? The answer to this question may be argued, especially in the absence of clarifications in the Regulation. Based on the experience gained from Regulations on emissions, one could propose to clarify the regulation with extended performance requirements beyond those defined for assessment in the Type Approval Test(s).

18. Regulation No. 51 (Noise) contains Additional Sound Emissions Provisions ("off cycle" test outside of the test procedure ("cycle") in Annex III) as software could be used to trigger sound reduction exclusively during driving conditions corresponding to those of the type approval test.

19. In general, testing procedures and their boundary conditions are chosen to reflect typical conditions that reflect the real world use, as far as possible.



20. If a test procedure broadly covers the different possible real situations, additional provisions might have a little impact. Alternatively, if the variance of real driving situations is high and is poorly covered by the conditions tested, the test procedure might need to be complemented by additional provisions to cover most of the relevant real world situations.

B. Additional provisions addressing other aspects than those covered by the type approval tests that address software performance

21. Regulations Nos. 13, 13-H and 79 contain specific provisions for the assessment of Complex Electronic (CEL) systems. The type approval tests verify the overall performance of the given system but can't provide sufficient performance verifications of all sub-functions of a complex electronic system. Therefore the Regulation requests from the applicant, in addition to the documentation and the type approval tests, the application of the CEL Annex which corresponds to a functional safety requirements and a verification test with a simulated malfunction /faulty.

Note: The TPMS malfunction is already covered by specific requirements differing from the Complex Electronic systems Annex.

C. *General provisions with clarification of their purpose*

22. Despite the comments above, *general provisions* without specified practical assessment may be inserted in regulations to specify the intention of the regulation, as it was proposed for TPMS. However, ideally they would be complemented by a clarification about their purpose.

23. In order to reduce the uncertainty related to their application by technical services and type approval authorities, the Regulator may wish to clarify that the approval granted doesn't certify the compliance with this *general provision* and is not subject to verification during the type approval process. The Regulator would not specify the way to verify the compliance with these provisions but would specify the intention of these provisions, i.e. for compliance enforcement issues. If proven that a given product doesn't comply with the *general provision* (e.g. due to the use of a software circumventing the Regulation), provisions of the Regulation may clarify that the Type Approval could be withdrawn, that a recall could be initiated or that penalties defined by international, regional or national regulations/laws may apply.

24. In order to keep these *general provisions* consistent with the usual practices within the Type Approval process, it is proposed that the information document may contain an item stating that the whole vehicle type complies with the said *general provision*.
